Waves in disordered media: transport and localization

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I hereafter provide you with a list of subjects for the oral exam on Monday, June, 26th. I will ask you few specific questions on one or several of these subjects. All these subjects have been covered during the lectures. You are allowed to bring with you (and look at) your hand-written (or computer-typed) lecture notes, but not any other document.

Disorder

- What is a disordered system? How to characterize it?
- What is Anderson localization?

One-dimensional systems

- Disordered Kronig-Penney model. Classical behavior. Transmission.
- Disordered Kronig-Penney model. Quantum behavior. Transfer Matrix method. Average transmission. Typical transmission.
- Disordered Kronig-Penney model. DMPK equation (no question on the technical aspects of the solution will be asked). Semi-quantitative behavior of the solution.
- Disordered Kronig-Penney model. Link between classical and quantum behaviors.

Scaling theory of localization

- What is a scaling theory?
- Thouless time. Heisenberg time. Dimensionless conductance.
- β function. Definition, properties, scaling hypothesis.
- β function in 1D and quasi-1D systems.
- β function in 2D systems.
- β function in 3D systems. Properties of the Anderson metal-insulator transitions.
- Anderson model.

Kicked Rotor

- Classical dynamics of the kicked rotor.
- Quantum dynamics of the kicked rotor. Dynamical localization.
- Floquet eigenstates of the kicked rotor. Mapping on an Anderson-like model.
- Localization length for the kicked rotor. Classical limit.
- Experiments on the kicked rotor.

Quantum theory of transport

- Retarded and advanced Green functions.
- Average Green function. How to compute it?
- Link between average Green function and average density of states.
- Dyson equation. Self-energy. Mean free path, mean free time.
- Diagrammatic expansion for the self-energy. Born approximation.
- Quantum intensity propagator. Bethe-Salpeter equation. Diagrammatic representation.
- Diffusive propagator (no technical question on its calculation). Ladder diagrams.

- Scattering mean free path, transport mean free path.
- Different representations of the diffusive propagator.

Weak localization

- Time reversed multiple scattering paths. Enhanced return to origin.
- Cooperon. Crossed diagrams.
- Weak localization. How to compute it in dimensions 1, 2 and 3?
- How to measure weak localization corrections?

Coherent backscattering

- What is coherent backscattering? How to distinguish it from incoherent effects?
- Qualitative explanation of CBS.
- Shape of the CBS peak.
- Temporal dynamics of CBS.

Dephasing - decoherence

- What is the dephasing phenomenon? How to take it into account in the quantum theory of transport?
- Matthiessen rule.
- Effect of decoherence on weak localization.
- Effect of absorption on CBS.
- Effect of polarization on CBS.

Self-consistent theory of localization

- What is a self-consistent theory?
- Self-consistent Born approximation.
- Self-consistent equation for the diffusion coefficient.
- Self-consistent theory of localization in dimensions 1, 2 and 3.